



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 95105-3901

OFFICE OF THE
REGIONAL ADMINISTRATOR

September 3, 1991

Mr. W. Don Maughan
Chairman
State Water Resources Control Board
State of California
P.O. Box 100
Sacramento, California 95801

RE: EPA Review of Bay/Delta Plan

Dear Mr. Maughan:

I am writing to inform you of the U.S. Environmental Protection Agency's (EPA's) action on the Water Quality Control Plan for Salinity for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay/Delta Plan). The Bay/Delta Plan was adopted by the State Water Resources Control Board (State Board) in State Board Resolution No. 91-34 on May 1, 1991, and submitted to EPA for approval on May 29, 1991.

In taking this action, EPA is aware of the substantial time and energy it has taken to develop the Bay/Delta Plan, and we are cognizant of the difficult issues the State Board faces as it establishes water quality standards for the estuary. We commend the State Board and its staff for seeking a high level of public involvement in the Bay/Delta proceedings.

Summary

As detailed below, by this letter EPA is taking the following actions:

(1) EPA is approving the salinity objectives for municipal/industrial and agricultural uses, and is approving the dissolved oxygen objective for fish and wildlife uses of the San Joaquin River. As to these objectives, EPA's action constitutes final agency action under Section 303(c) of the Federal Clean Water Act.

(2) EPA is disapproving the Bay/Delta Plan's objectives because of their failure to protect the Estuarine Habitat and other designated fish and wildlife uses of the estuary. EPA is also disapproving certain salinity and temperature objectives. Under the Clean Water Act, the disapproved objectives remain in effect until replaced by new or revised objectives adopted by the State or promulgated by EPA. The State has 90 days to adopt any necessary revisions. If the State does not adopt the necessary revisions, EPA must propose and promulgate revised standards for the State. Therefore, today's disapproval does not constitute final agency action under Section 303 of the Clean Water Act.

EPA's Review of Standards

Under Section 303 of the Federal Clean Water Act and EPA's implementing regulations, states are to establish designated uses for waterbodies, and must adopt water quality criteria sufficient to protect those designated uses. EPA is to review and approve or disapprove all state-adopted water quality standards. In reviewing water quality criteria, EPA considers whether the criteria contain sufficient parameters to protect the designated uses and are based on sound scientific rationale. If EPA determines that the criteria will not protect the designated uses, or were not based on sound scientific rationale, it is to disapprove the criteria and describe the changes it believes are necessary to provide adequate criteria. The State then has 90 days to adopt criteria meeting the requirements of the Act. If it fails to do so, EPA must promptly propose and promulgate new or revised criteria consistent with the requirements of the Act. At any time during EPA's promulgation effort, including after any such promulgation, the State can adopt acceptable criteria and thereby terminate EPA's promulgation action.

California's Bay/Delta Plan establishes "objectives" for salinity, temperature, and dissolved oxygen for the waters of the Bay/Delta estuary. In accordance with our past practices, EPA will treat these "objectives" as the equivalent of "water quality criteria" for all purposes under the Act.

Standards Approved

EPA has reviewed the State Board's submittal and has concluded that the salinity objectives for municipal/industrial and agricultural uses are consistent with the protection of those uses and otherwise comply with the requirements of the Clean Water Act. Those objectives are described on pages one through four of Table 1-1 of the Bay/Delta Plan. Accordingly, EPA hereby approves the Bay/Delta Plan's salinity objectives for municipal/industrial and agricultural uses.

EPA also approves the 6 mg/l dissolved oxygen objective for the designated fish and wildlife uses on the San Joaquin River. This objective is described on page five of Table 1-1.

EPA's action approving the above objectives as water quality criteria under Section 303 of the Federal Clean Water Act constitutes final agency action on those objectives for purposes of this triennial review.

Standards Disapproved

I. Objectives Protecting Estuarine Habitat Uses

To be consistent with the Clean Water Act and the accompanying Regulations, the State's objectives must be sufficient to protect Estuarine Habitat and other designated fish and wildlife uses. The Estuarine Habitat use, which has been formally approved by the State and EPA as part of the State's water quality standards, was established to provide "an essential and unique habitat that serves to acclimate anadromous fishes (salmon, striped bass) migrating into fresh or marine conditions. This habitat also provides for the propagation and sustenance of a variety of fish and shellfish, numerous waterfowl and shore birds, and marine mammals." Water Quality Control Plan, San Francisco Bay Basin[2], December 1986, at II-4. The other fish and wildlife uses of the estuary designated for protection include Cold and Warm Water Habitat, Fish Migration, Fish Spawning, Ocean Commercial and Sport Fishing, Preservation of Rare and Endangered Species, Shellfish Harvesting, and Wildlife Habitat. Bay/Delta Plan, Ch. 4, at p. 4-1 to 4-3.

During the review process of the 1978 Delta Plan, EPA and the State Board agreed to use the Striped Bass Index (SBI) as a measure of whether the fish and wildlife uses of the estuary were being protected. The State Board committed to revising the 1978 Delta Plan objectives if the SBI showed a measurable decrease below the predicted levels. See Letter from Paul De Falco, Jr., Regional Administrator of EPA, to Carla M. Bard, Chairwoman, SWRCB, dated August 28, 1980 (1980 Approval Letter), and Letter from Carla M. Bard, Chairwoman, SWRCB, to Sheila M. Prindiville, Acting Regional Administrator, EPA, dated November 21, 1980 (1980 Approval Letter). We have previously noted that the SBI has in fact decreased substantially below the predicted level. See Letter from Judith E. Ayres, Regional Administrator, EPA, to W. Don Maughan, Chairman, SWRCB, dated June 29, 1987; Letter from Daniel W. McGovern, Regional Administrator, EPA, to W. Don Maughan, Chairman, SWRCB, dated February 23, 1990. The drop in the SBI has been dramatic. Whereas the 1980 Approval Letter stated a target SBI of 79, the average SBI since 1978 has been approximately 25, and it has dropped to less than five during the past few years. Even before the most recent decline in the SBI, the State Board had acknowledged the crisis in the estuary's fisheries: "The decline in the Striped Bass Index clearly indicates that current standards are not adequate to protect the fishery resource." Letter from Raymond Walsh, Interim Executive Director, SWRCB, to Judith E. Ayres, Regional Administrator, EPA dated June 23, 1986.

The precipitous decline in striped bass is indicative of the poor health of other fisheries resources in the estuary. Several species, including the Chinook salmon (the winter run of which is listed as an endangered species), the Delta Smelt (recently proposed for listing as a threatened species) and the Sacramento splittail (a candidate for listing as an endangered species), have experienced similar declines. In fact, the California Department of Fish and Game (DFG) recently testified that virtually all of the estuary's major fish species, as well as its lower trophic levels, are in clear decline.

In our 1987 Triennial Review Letter, EPA outlined the inadequacy of the set of objectives protecting the fish and wildlife uses, but agreed to postpone action on the objectives pending submission of revised objectives pursuant to the present triennial review. In the February 5, 1987 Workplan for the triennial review, the State agreed to adopt a comprehensive set of revised objectives by August 1989 for submittal to EPA. Nevertheless, the State Board's recent submittal concedes that "other than the striped bass spawning objectives, the proposed Plan is essentially identical to the 1978 Delta Plan." Responses to Comments at II-59.

The record, therefore, does not support the conclusion that the State has adopted criteria sufficient to protect the designated uses. Accordingly, pursuant to the authority vested in the Administrator by Section 303(c)(3) of the Clean Water Act and 40 CFR 131.5 and 131.21 and delegated to me, I hereby disapprove the current set of objectives contained in the State Board's Bay/Delta Plan because they fail to protect the Estuarine Habitat and the other designated fish and wildlife uses of the estuary.

Given the evidence in the record, there are various options at the State Board's disposal for developing objectives that would be approvable under the Clean Water Act. One option would be for the State Board to adopt additional salinity and temperature standards protecting the designated uses of the estuary. Alternatively, the State Board could follow the approach taken in its November 1988 Draft Plan and adopt flow objectives that would be protective of the designated uses. Similarly, the State Board could adopt biological objectives that could serve as measurable indicators of whether the uses are protected. This list of alternatives is not intended to be exhaustive; the State Board can choose any set of objectives that protect the designated uses of the estuary. We are willing to work closely with the State Board to develop scientifically-defensible objectives that meet the requirements of the Clean Water Act.

II. Salinity Objectives

We are also disapproving certain of the Bay/Delta Plan's salinity objectives. The Bay/Delta Plan includes salinity objectives for only a short reach of the lower San Joaquin River and for the managed wetlands of Suisun Marsh. After carefully reviewing the State Board's submittal, I have determined that these objectives are insufficient to protect the designated uses of those waterbodies, and that additional salinity objectives are needed to protect the designated fish and wildlife uses of the estuary.

A. Suisun, San Pablo, and San Francisco Bays

There are currently no salinity objectives to protect fish and wildlife in Suisun, San Pablo, and San Francisco Bays. There is significant scientific evidence that salinity objectives for these areas are necessary to maintain adequate levels of production at the base of the estuary's food chain and to protect the habitat for those species restricted to brackish water during all or part of their life cycles. We are especially concerned that no salinity objectives have been set to protect habitat for Delta Smelt, a candidate for protection under the Federal Endangered Species Act. The Bay/Delta Plan itself states that "Delta smelt habitat indicates a salinity preference of less than 2 [parts per thousand (ppt)] and seldom greater than 10 ppt" and concludes that "existing knowledge suggests that salinities of 2 ppt or less are desired in Suisun Bay from March through June." Bay/Delta Plan, at 5-44.

Accordingly, I hereby disapprove the Bay/Delta Plan because it fails to adopt salinity standards in the Suisun, San Pablo, and San Francisco Bays that are protective of the Estuarine Habitat and other designated fish and wildlife uses of the estuary. To be approvable by EPA, the Bay/Delta Plan should be revised to include a maximum salinity objective of 2 ppt at appropriate locations in these waterbodies, or an alternative objective that is scientifically defensible and protective of the designated uses.

B. San Joaquin River

The Bay/Delta Plan includes salinity objectives to protect spawning conditions for adult striped bass in the lower San Joaquin River. The Plan established objectives of 1.5 millimhos per centimeter electroconductivity (mmhos/cm EC) at Antioch and 0.44 mmhos/cm EC at Prisoners Point in April and May. EPA is disapproving these objectives for the following reasons:

1. The salinity objectives do not provide protection for the designated Fish Spawning use of the San Joaquin River in the reach between Prisoners Point and Vernalis.

The Bay/Delta Plan notes that salinity in the San Joaquin River increases upstream of Prisoners Point due to saline agricultural return flows. Thus the absence of salinity objectives above Prisoners Point effectively establishes a barrier to adult migration and spawning further upstream on the San Joaquin River. DFG has testified that striped bass occasionally spawn above Prisoners Point, but this activity has diminished because of poor water quality. Nevertheless, despite the recommendations of DFG and the U.S. Fish and Wildlife Service (USFWS), the State Board did not establish salinity objectives to protect striped bass spawning in the reach between Prisoners Point and Vernalis.

In order to approve the State's water quality standards for this reach of the San Joaquin River, EPA must find that they contain sufficient parameters to support the designated uses. Therefore, EPA disapproves the State's objectives in the lower San Joaquin River between Prisoners Point and Vernalis for failure to include salinity objectives that protect striped bass spawning.

EPA recognizes that DFG and others have expressed concern that protection of the spawning habitat upstream of Prisoners Point may increase the possibility of eggs and young being trapped and killed at the state and federal pumps in the southern Delta. Thus we recommend that the State Board's implementation measures for the revised objectives be developed in conjunction with measures to reduce the impacts of the pumps on spawning habitat.

2. The Antioch and Prisoners Point objectives are not based on sound scientific methods, as required by 40 CFR 131.11(b).

In comments on the Draft Bay/Delta Plans, EPA asked the Board to fully explain the scientific basis for the 1.5 mmhos/cm EC objective at Antioch. Several parties questioned this objective in light of DFG's testimony that striped bass spawn primarily at EC levels of less than 0.3 mmhos/cm, and seldom migrate up the San Joaquin River to spawn when EC levels exceed 0.44 mmhos/cm.

In the final Bay/Delta Plan, the State Board explained that the 1.5 mmhos/cm EC objective was designed to provide suitable spawning habitat upstream of Antioch, not at the Antioch location itself. The State Board acknowledged that "the use of 1.5 EC at Antioch appears not to be generally appropriate," and proposed that "a thorough review of this objective be undertaken at the next Triennial Review." Bay/Delta Plan, at p. 5-32.

The Bay/Delta Plan also acknowledged that "the spawning objectives do not in fact designate a spawning reach, but only a single location (Prisoners Point) where appropriate salinities for the majority of spawning, as determined by DFG, are required to be present." Bay/Delta Plan at page 5-30. As a result, the Plan directs the DFG to study how a specific habitat zone of 0.44 mmhos/cm EC could be established in the reach between Jersey Point and Prisoners Point "to make certain that the State Board develops water quality objectives that are based on sound scientific data." Bay/Delta Plan at p. 5-33.

Finally, the Plan acknowledged that the relaxation provision of the Antioch objective is not based on sound scientific methods. The Plan noted that "deficiencies in firm supplies and the level of protection afforded by the striped bass spawning objective should be correlated. The present deficiency schedule does not do that, since no specific relationship between extent of habitat and change in salinity intrusion has been made....Several participants have appropriately questioned the basis for this relationship." Bay/Delta Plan at p. 5-32. Again, the Board directed DFG and others to reevaluate this provision in the next triennial review.

EPA believes that given the State Board's own statements that the objectives are inadequate - a conclusion we fully share - these objectives must be revised now and not postponed until the next triennial review. The Board has had ample opportunity to develop new objectives based on sound scientific methods since the results of the last triennial review were submitted in 1985. Therefore, we disapprove the State's salinity criteria for the lower San Joaquin River because they are not based on scientifically defensible methods.

In summary, I disapprove the State's salinity objectives for the San Joaquin River portion of the Delta because they are insufficient to protect the designated fish and wildlife uses and are not based on sound scientific methods. To be approvable by EPA, the Bay/Delta Plan should be revised to include a maximum salinity objective of 0.44 mmhos/cm EC from Jersey Point to Vernalis, or an alternative objective that is scientifically defensible and protective of the designated uses.

C. Suisun Marsh

1. **Salinity Objectives.** The salinity objectives for Suisun Marsh remain unchanged from the 1978 Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh (1978 Delta Plan). These objectives were established to protect plants and wildlife in the managed wetlands of the Marsh. EPA's approval of the 1978 Delta Plan objectives was explicitly conditioned on the State's commitment to develop additional objectives and to protect aquatic life in the Suisun Marsh channels and open waters. See 1980 Approval Letter. These conditions have not been met; there are currently no salinity objectives to protect the aquatic life and the tidal wetland habitat. Accordingly, I disapprove the salinity objectives for the Marsh because they fail to protect the Estuarine Habitat, Wildlife Habitat, and other fish and wildlife uses of the waterbodies in and around Suisun Marsh. To meet the requirements of the Clean Water Act and EPA regulations, the State Board should immediately develop salinity objectives sufficient to protect aquatic life and the brackish tidal wetlands surrounding the Marsh.

2. Clarification of Existing Objectives. We note that the State Board's implementation requirements for the existing salinity objectives (Table 1-2) contain a different set of "objectives" that may significantly reduce protection for both the managed and tidal wetlands of the Marsh. The implementation requirements are based on amendments made to the water rights permits of the state and federal projects in 1985. The amendments eliminated the two westernmost stations in Suisun and Montezuma Sloughs and relocated several others. These changes were made without the benefit of a public hearing or environmental review, and were never adopted and submitted to EPA as formal revisions to the 1978 Delta Plan.

Since the State Board has not formally amended this component of the 1978 Delta Plan, the 1978 Delta Plan objectives specified in Table VI-I of that Plan continue to be the water quality objectives in the Suisun Marsh for all purposes under the Act. We believe that it is inconsistent with the Act for the State Board to adopt one set of objectives as water quality criteria but to adopt implementation plans using a different and inconsistent set of objectives. The implementation plans required under Section 303(e)(3)(F) of the Act should be consistent with the 1978 Plan objectives. Should the State Board desire to change those objectives, it must adopt revised objectives in accordance with 40 CFR 131.20, and must submit any such revisions to EPA for review under 40 CFR 131.21.

III. Temperature Objectives

A. Fall-run chinook salmon

The Bay/Delta Plan includes new temperature objectives of 68 degrees at Freeport on the Sacramento River and Vernalis on the San Joaquin River from April 1 through June 30 and from September 1 through November 30 to protect Cold Water Habitat for fall-run salmon. The Plan notes that high water temperatures have been a major problem for fall-run salmon smolts emigrating through the estuary.

The supporting analysis in the State's submittal, however, is not consistent with the adopted objectives. The Technical Appendix states that "juvenile emigrants (smolts) can tolerate water temperatures somewhat higher than 60 degrees, but above about 65 degrees a variety of stress effects occur," and adds that smolts are "highly stressed" at 68 degrees or more (5.3-1). The Bay/Delta Plan also cites studies that temperatures above 65 degrees have blocked salmon migrations.

In addition, the Bay/Delta Plan's temperature objectives are inconsistent with DFG's 1990 Central Valley Salmon and Steelhead Restoration and Enhancement Plan, which states that maximum growth occurs from 54-60 degrees, and that growth ceases above 65 degrees (p. 78).

In summary, the State's temperature objectives for the fall-run salmon are contrary to the extensive evidence in the State's submittal that fall-run salmon would not be protected at temperatures of 68 degrees. Accordingly, I hereby disapprove these objectives because of their failure to protect Cold Water Habitat and other fish and wildlife uses. To be approvable by EPA, the Bay/Delta Plan should be revised to include a maximum objective of 65 degrees, or an alternative objective that is scientifically defensible and protective of the designated uses.

B. Winter-run Salmon

The Bay/Delta Plan also includes a new temperature objective of 66 degrees at Freeport on the Sacramento River from January 1 through March 31 to protect winter-run salmon. However, the supporting evidence in the State's submittal is insufficient to approve this objective. The Plan acknowledges that "there was no testimony presented on the temperature requirements specifically for the winter-run." Bay/Delta Plan, at 5-23.

In addition, both the USFWS and DFG opposed this objective because it is considerably higher than present temperatures at Freeport. According to the USFWS, average temperatures in this reach during the winter range from about 45 to 60 degrees. The USFWS concluded that they "cannot envision when such an objective would be beneficial." USFWS, Comments on Final Draft Water Quality Plan, January 1991, at p. 5.

Therefore, I disapprove the State's temperature objective for winter-run salmon because it is not based on sound scientific rationale. The objective should be removed and replaced with an objective based on better-supported evidence of the temperatures required to protect Cold Water Habitat for winter-run salmon and other species.

C. "Controllable Factors" Limitation

Finally, the State's requirement that temperature objectives be subject to "controllable factors" is inconsistent with EPA regulations. Water quality criteria are to be scientifically based and protective of the designated uses. Consideration of other factors may be appropriate in designating uses, but not in establishing water quality criteria.

EPA recognizes that temperature objectives may be difficult to implement in the estuary. However, this concern should be addressed in the State's implementation plan, through variance provisions, or other approaches consistent with EPA regulations. The objectives themselves must be established to protect the designated uses and be based on sound scientific rationale.

CONCLUSION

As to the objectives that are being disapproved pursuant to this letter, the State has 90 days from the date of this notification letter to adopt and resubmit approvable objectives. The State may make the changes recommended in this letter or adopt an alternative set of objectives sufficient to protect the designated fish and wildlife uses of the estuary. If the State does not adopt approvable objectives within 90 days, EPA must initiate Federal promulgation of acceptable standards. The State's submitted objectives will continue to be in effect until they are replaced either by the State or by a Federal promulgation. If the State adopts approvable objectives, EPA will cease its Federal promulgation efforts.

In closing, I intend to make every effort to work cooperatively with the State to protect and enhance the fisheries and other uses in the Bay and Delta. I also strongly support the consensus process now underway among the State's environmental, urban, and agricultural interests to develop a new framework for California water management. In the spirit of that effort, I hope our agencies will continue to work towards solutions that are broadly acceptable and environmentally sound.

Sincerely,

A handwritten signature in dark ink, appearing to read "Daniel W. McGovern". The signature is fluid and cursive, with the first name "Daniel" being the most prominent.

Daniel W. McGovern
Regional Administrator

- o Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the water of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs, and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.
- o No temperature requirements were submitted for winter-run Chinook salmon. To provide some protection for this endangered species, the more conservative temperature objective of 66°F (developed for the fall-run) is provided for the winter-run. This objective should be achieved by controllable factors, as noted above, during the period January through March at Freeport on the Sacramento River.

5.5.1 Present Conditions

* Flow requirements in D-1485 were established at Rio Vista on the Sacramento River for the protection of Chinook salmon, Oncorhynchus tshawytscha. There are no fishery flow requirements for the San Joaquin portion of the Delta. In addition to flow requirements, D-1485 contains a provision to close the Delta Cross Channel to minimize cross-Delta movement of salmon. D-1485 does not include any water quality objectives for the protection of salmon.

5.5.1.1 Salinity, Temperature and Dissolved Oxygen

Various water quality conditions can affect Chinook salmon survival in the Delta. The water quality variables under consideration were temperature, dissolved oxygen (DO) and salinity. During and after Phase I of the proceedings, data were presented on some water quality requirements of the different runs of Chinook salmon during the freshwater life stages. Most of the information concerning water quality is related to temperature requirements.

No salinity objectives exist for salmon in the Sacramento and San Joaquin basins and Delta, and no salinity objectives have been proposed. Chinook salmon (adults and juveniles) tolerate and even benefit from a gradual salinity gradient from the upstream headwaters to the ocean. The Chinook salmon as they migrate through the Delta are genetically adapted to migrate well beyond the fresh and salt water boundary.

Natural populations of San Joaquin and Sacramento salmon are declining and San Joaquin populations are undergoing extreme fluctuations (USFWS, 31, 58). Natural populations of the fall-, late fall-, winter- and spring- Chinook salmon runs are smaller than they were when first recorded by DFG in 1959. The catch of fall-run Chinook salmon has been relatively stable over time because the increasing number of hatchery-produced fish has offset the decline in naturally-produced fish.

The winter-run Chinook salmon has been listed as an Endangered Species under State law by the Fish and Game Commission and as a Threatened Species under federal law by the National Marine Fisheries Service (NMFS). Additional information about this run has been submitted to the State Board (see below).

San Joaquin River flow at Vernalis during smolt emigration has been identified as a major factor affecting subsequent adult escapement of hatchery and naturally-produced Chinook two and one-half years later (T,XXXVI,139:17-22) (Figures 5-1 and 5-2). The temperatures in the south Delta are often too high for smolts (WQCP-USFWS-5). Survival of the hatchery fish transported by truck and released below the Delta is six to eight times better than naturally or hatchery-produced fish emigrating from upstream through the Delta (T,XXXVII,153:2-154:1,161:22-162:1).

Very little water quality information is available about the effects of present conditions on salmon smolts migrating through San Francisco Bay. The USFWS did however determine that Chinook survival through San Francisco Bay in 1985 was estimated to be 93 percent based on the ratio of tag recoveries of two and three-year-olds released at both Port Chicago and the Golden Gate Bridge, respectively (Table 15, see USFWS Exhibit 31 for methods). The survival rate in 1984 was 81 percent. Both years had a delta outflow of about 10,000 cfs during the smolt out-migration (WQCP-USFWS-3,54).

5.5.1.2 Legislation for Upper Sacramento River Fishery Resources and Riparian Vegetation Restoration

A number of efforts are being made in both the state legislature and congress to improve the anadromous fishery and the riparian vegetation in the upper Sacramento River. In 1986, Senate Bill 1086 (Nielsen) created an advisory council and action team of federal, state and local agencies and interested parties to develop the Upper Sacramento River Fisheries and Riparian Habitat Management Plan. The plan, submitted in 1989, addressed the issues concerning the declining population of anadromous fish in the Sacramento River and listed 22 specific actions to restore and protect the fisheries and riparian vegetation. The plan includes priority issues such as flows, modification of diversion facilities, and temperatures and turbidity control in the Sacramento River. Senate Concurrent Resolution 62 (Nielsen), filed as a follow-up to SB 1086, passed in October, 1989. The Resolution declares that it is state policy to proceed with appropriating sufficient funds to implement the various recommendations in the management plan.

5.5.2 State Board Considerations

5.5.2.1 Temperature

There are a number of factors that influence water temperatures in the Delta; they include water temperatures of tributary inflow, amount of inflow, solar radiation, ambient temperatures, temperature of irrigation return flow and the extent of the riparian vegetation or shade. There is

SUMMARY OF TESTIMONY OF
U.S. FISH AND WILDLIFE SERVICE

Richard DeHaven
Cay Collette Goude
Richard J. Morat

The above biologists will present the specific comments of the U. S. Fish and Wildlife Service on the Interagency Ecological Study Program's reports to be submitted by parties to the Program.

SUMMARY OF DIRECT TESTIMONY OF
EDWARD M. LORENTZEN
FISH AND WILDLIFE BIOLOGIST, SACRAMENTO, CALIFORNIA
UNITED STATES FISH AND WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR
TO BE PRESENTED DURING THE WATER RIGHT/WATER QUALITY HEARING
SCHEDULED FOR SEPTEMBER 29 & 30, 1987

The available fisheries survey data indicate that two native Delta fishes, Delta smelt (Hypomesus transpacificus) and Sacramento splittail (Pogonichthys macrolepidotus), are currently experiencing significant declines in their distribution and abundance. General distribution maps for these two fishes were previously submitted to the Board as U.S. Fish and Wildlife Service Exhibits 23 and 24. In response to their declining status, the Portland Regional Office of the Fish and Wildlife Service recently recommended that these two fishes be added to our candidate species list. The Service is now examining the available data to determine whether either of these species qualifies for addition to the List of Endangered and Threatened Wildlife pursuant to Section 4 of the Endangered Species Act of 1973.

The Delta smelt may be especially vulnerable to extinction from modifications to the Delta environment because of its restricted range and extremely short life cycle. Most Delta smelt do not live beyond one year of age. The reproductive failure of two successive year classes would likely result in the extinction of this fish.

The California Department of Fish and Game has been keeping records on the relative abundance of Delta smelt since 1967. An index of Delta smelt abundance has been derived from collections made by the Department in its annual fall trawl survey of the Delta. In recent years, the Delta smelt index has declined to the lowest levels on record -- less than 10% of peak year abundance. In some parts of the Delta where the Delta smelt was once common, such as Suisun Marsh, it has nearly disappeared from the catch in recent trawl surveys.

The magnitude of the recently observed decline in Delta smelt abundance is depicted in the Table 1 and Figure 1. These data are now being examined in conjunction with data recorded concurrently on Delta environmental conditions to see if any environmental parameters are significantly correlated with the observed decline in Delta smelt abundance.

TABLE 1

Delta smelt abundance indices, 1967-1986. Numbers represent the sum of weighted catches for the Department of Fish and Game's September-December Delta trawl surveys.

<u>Year</u>	<u>Delta Smelt Index</u>
1967	414
1968	690
1969	315
1970	1679
1971	1298
1972	1375
1973	1145
1974	No Survey
1975	682
1976	435
1977	505
1978	657
1979	No Survey
1980	682
1981	435
1982	1229
1983	133
1984	168
1985	105
1986	198

Source: Unpublished file data, Bay-Delta Project Office, California Department of Fish and Game, Stockton

FIGURE 1

Graph depicting Delta smelt abundance indices, 1967-1986.
Source: Unpublished file data, Bay-Delta Project Office,
California Department of Fish and Game, Stockton



SUMMARY OF QUALIFICATIONS

Name: Richard W. DeHaven

Employer: U.S. Fish and Wildlife Service
Division of Ecological Services
2800 Cottage Way, Room E-1803
Sacramento, California 95825

Position: Fish and Wildlife Biologist

Education: B.S. Wildlife and Fisheries Biology
Colorado State University, Fort Collins, Colorado 1967

Work and Professional Experience:

03/85 - Present: Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, Division of Ecological Services, Sacramento, California. Primary duties involve (1) evaluation of water development projects to determine their impacts on fish and wildlife resources, and (2) development of appropriate mitigation recommendations for such projects.

05/69 - 03/85: Wildlife Research Biologist, U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Dixon, California Field Station. Project Leader, in charge of research on various problems caused by migratory birds, including bird hazards to aircraft and bird depredations to agricultural crops. Planned, conducted, evaluated, and reported research studies. Published more than 25 scientific and popular articles.

01/74 - 01/79: As a private individual, conducted 5-year research study of striped bass populations in the American River, California, in cooperation with the California Department of Fish and Game. Prepared five annual reports of activities and findings.

01/67 - 05/69: Wildlife Biologist, U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Denver, Colorado. Assisted in research studies involving bird depredations to various agricultural crops.

SUMMARY OF QUALIFICATIONS

Name: Cay Collette Goude

Employer: U.S. Fish and Wildlife Service
Division of Ecological Services
2800 Cottage Way, Room E-1803
Sacramento, California 95825

Position: Fish and Wildlife Biologist

Education: B.S. Renewable Natural Resources (emphasis in fisheries)
University of California, Davis 1976

M.S. Biology (Fisheries)
California State University, Sacramento 1981

Work
Experience: 10/84 - Present: Fish and Wildlife Biologist, U.S. Fish
and Wildlife Service, Division of Ecological Services,
Sacramento, California. Primary duties are preparing
Fish and Wildlife Coordination Act reports and providing
technical assistance on Section 404/10 permits.

11/79 - 10/84: Environmental Resource Planner, U.S. Army
Corps of Engineers, Sacramento District, Sacramento,
California. Primary duties were: preparation of environ-
mental assessments and Environmental Impact Statements;
designing, coordinating, contracting, and reviewing studies
to assess fisheries impacts of various projects; transfer
fund coordinator; and the Corps' main participant when a
Habitat Evaluation Procedure was conducted.

12/78 - 11/79: Biological Technician, U.S. Army Corps of
Engineers, Sacramento District, Sacramento, California.

SUMMARY OF QUALIFICATIONS

Name: Richard John Morat

Employer: U.S. Fish and Wildlife Service
Division of Ecological Services
2800 Cottage Way, Room E-1803
Sacramento, California

Position: Fish and Wildlife Biologist

Education: B.S. Fisheries Management 1969
Humboldt State College

Work
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WHERE HAVE CALIFORNIA'S STRIPED BASS GONE?

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INTRODUCTION

California's Sacramento-San Joaquin Estuary striped bass population has suffered a serious decline over the past 25 years. An analysis of catch records in conjunction with more recent population estimates suggests that in the early 1960s the adult striped bass (larger than 16 inches) population numbered about 3 million fish. Petersen mark-recapture estimates (Figure 1) indicate that adult bass abundance declined to 1.6-1.8 million fish by the early 1970s and about 0.8-1.1 million fish in the 1980s.

The adult stock has decreased primarily because a decline in young striped bass production (Figure 2) has led to lower recruitment, although, based on tag returns, an increase in adult mortality in the 1970s also contributed to this depletion (CFG 1987).

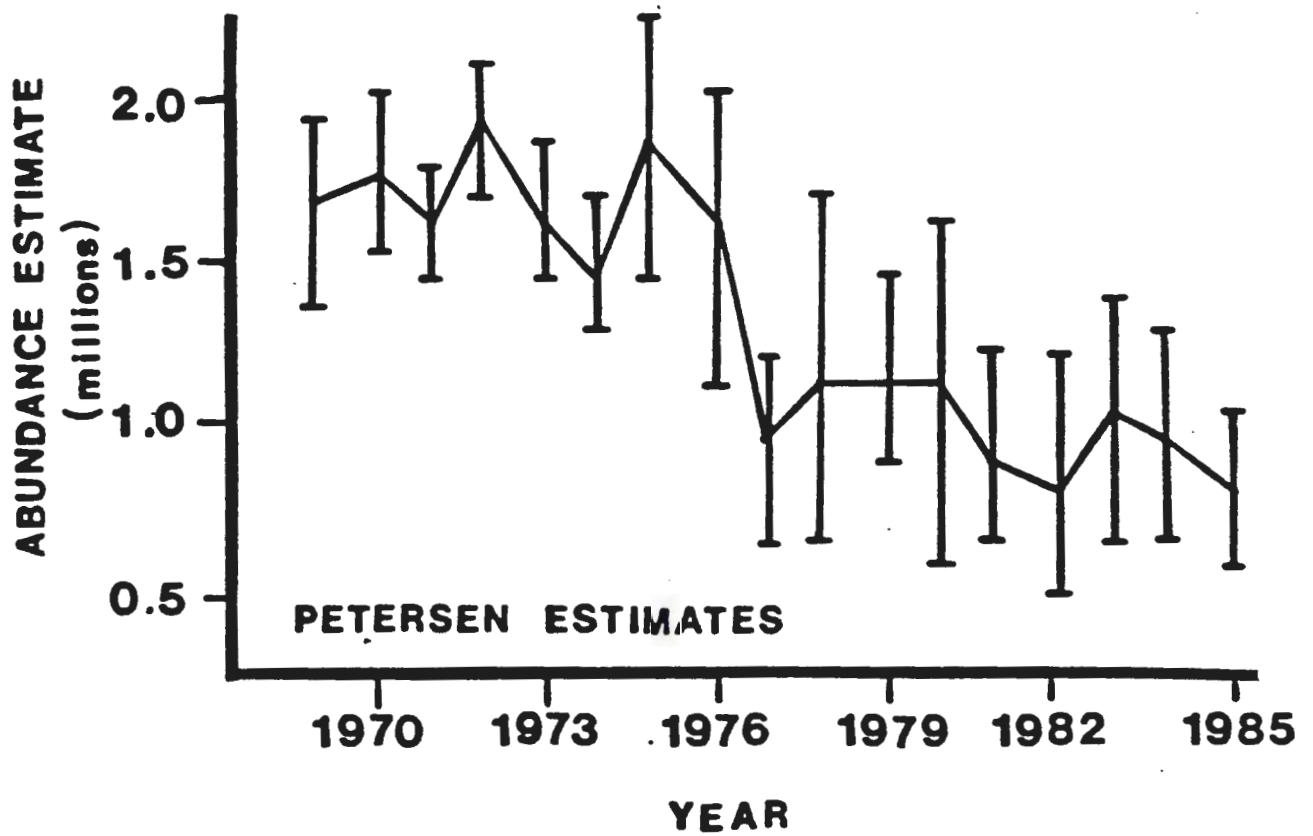


Figure 1. Trend in abundance of adult striped bass (at least 16 inches total length) as measured by Petersen mark-recapture estimates. Measures of precision in the form of 95% confidence intervals are depicted by the vertical bars.

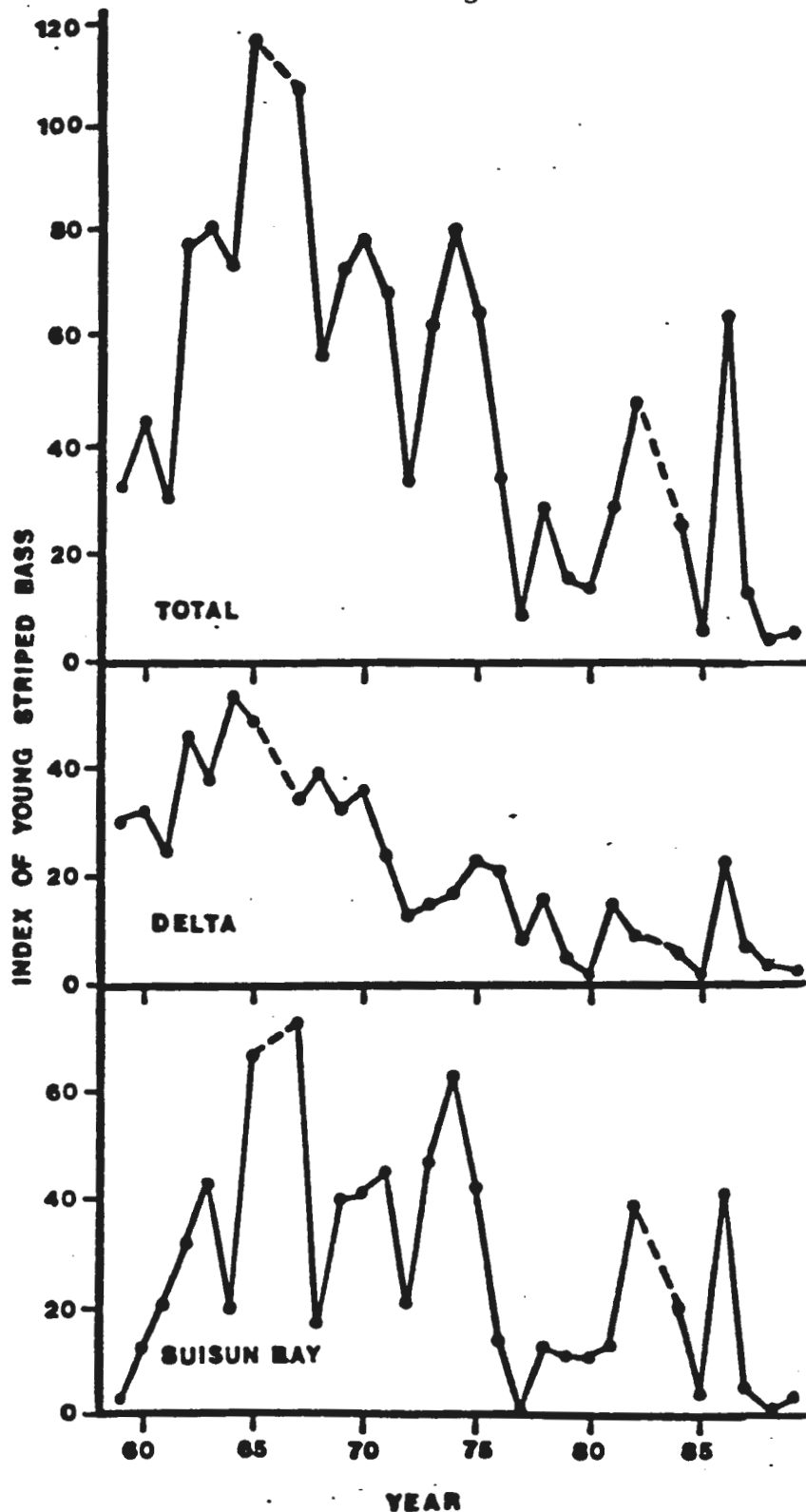


Figure 2. Annual index of young striped bass abundance by area in the Sacramento-San Joaquin Estuary. Young bass suffered an unsteady but persistent decline from the mid-1960s to 1985. The decline was most pronounced in the Delta, but also is clearly visible in Suisun Bay despite greater year-to-year fluctuations there. In 1986 young striped bass abundance rebounded to its highest level since 1975. No sampling was conducted in 1966 and the 1983 index was omitted because extremely high flows transported most young bass downstream from the area effectively sampled by the tow net survey.

Major studies (Turner and Chadwick 1972; Chadwick et al. 1977; Stevens et al. 1985; CFG 1987) have evaluated factors controlling young striped bass production. Initially (1959-1970), annual fluctuations in young bass abundance could be explained by a simple regression model based on Delta outflow which indicated that young bass production was substantially greater in years with high spring/early summer flows than in years with low flows (Figure 3a). The mechanism causing the most abundant year classes to occur under high flow conditions was unknown. However, one potential explanation centered on a similar but inverse relationship between young bass abundance and the percentage of inflow to the Delta that was diverted by the combination of major water projects (Central Valley Project [CVP] and State Water Project [SWP]) and local Delta agriculture (Figure 3b). The implication was that when the diversion percentage was high, more young bass would be entrained in diverted water and removed from the estuary. Other potential explanations for the greater abundance in high flow years included (i) expansion of the nursery area resulting in greater habitat availability and less competition, (ii) higher food production (iii) dilution of toxicity, and (iv) reduction in predation losses due to more turbid conditions (Turner and Chadwick 1972; Stevens 1977).

In the early 1970s, production of young bass began to fall below the levels expected based on the initial regression models (Figure 4) and this decline was most acute in the Delta portion of their nursery (Figure 2). During this period the SWP and CVP

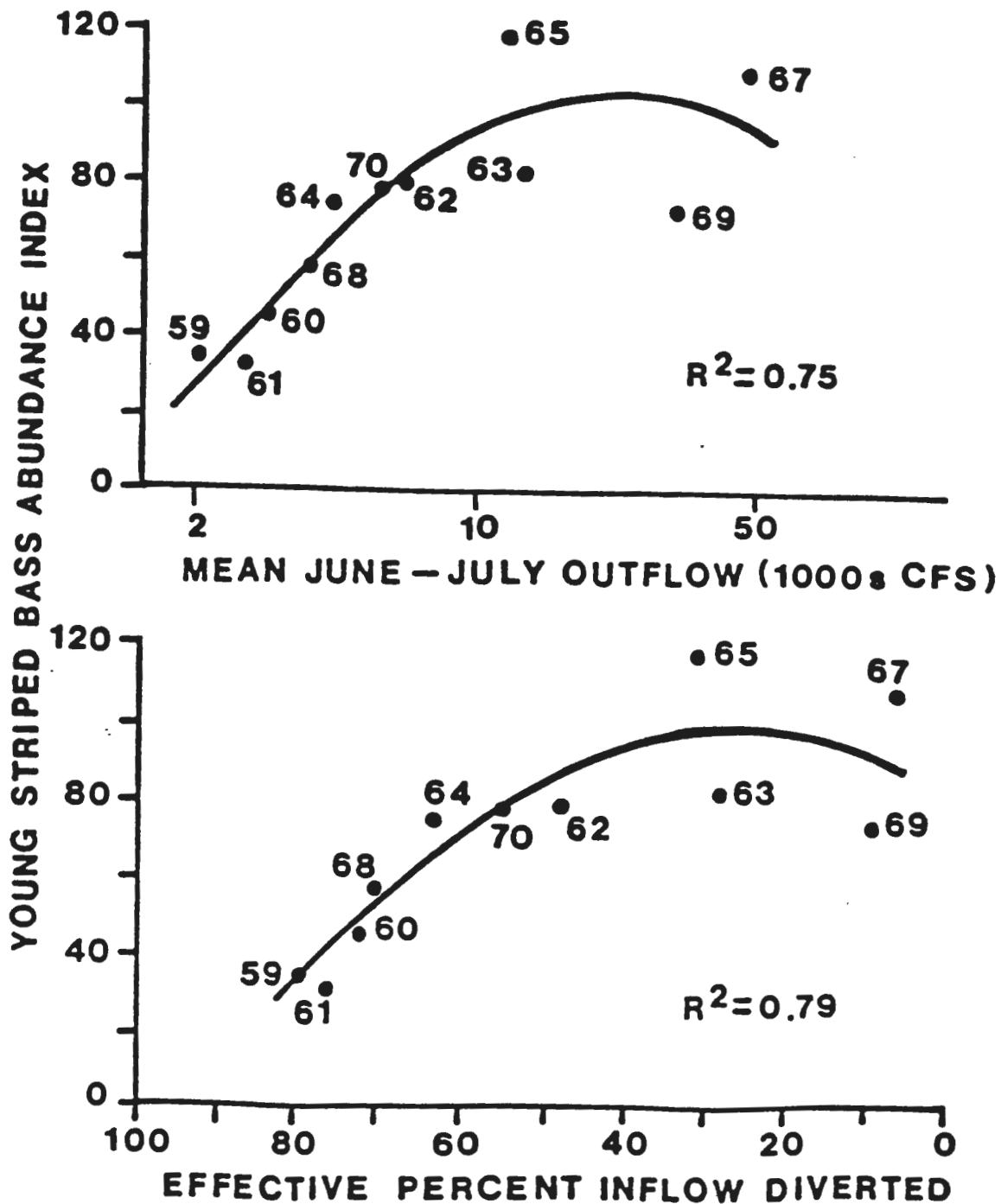


Figure 3. Relationship between total abundance of young striped bass in the Sacramento-San Joaquin Estuary and Delta outflow and diversions from 1959 to 1970. In years when outflow was high and percent of river inflow diverted was low, the striped bass index was high; conversely, when outflows were low and the percent diverted was high, the young striped bass index was low. Effective percent inflow diverted is the portion of Delta inflow diverted for internal use and exports, except that the portion of the San Joaquin River inflow not reaching the western/central Delta is not included in the calculations.

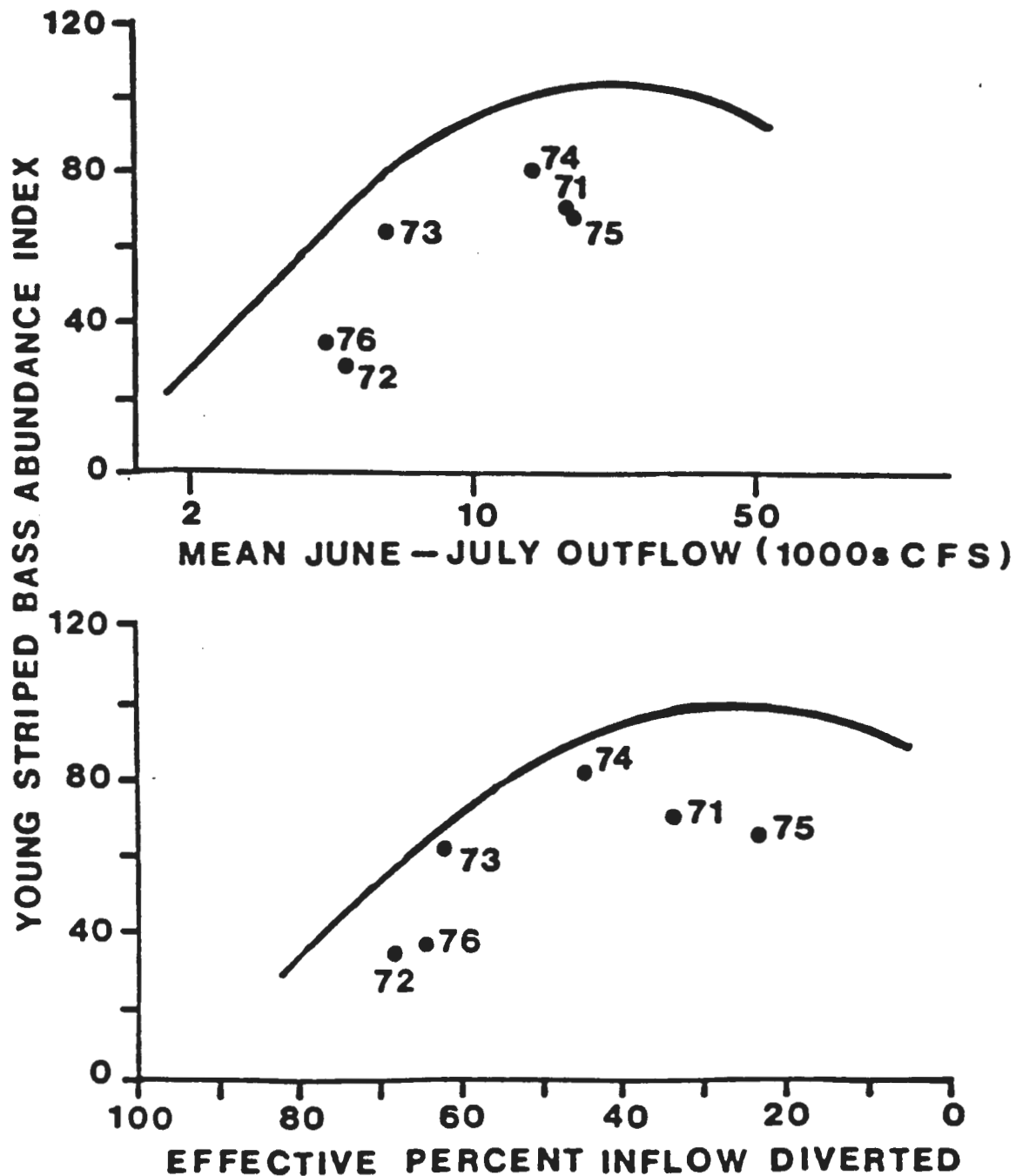


Figure 4. Comparison of the relationships between total abundance of young striped bass and outflow and diversion rates in the Sacramento-San Joaquin Estuary for 1987-1976 (data points) and 1959-1970 (curves from Figure 3). In the early to mid-1970s, young bass abundance was consistently lower than expected based on the 1959-70 relationship.

substantially increased their water export from the Delta resulting in greater diversion rates being associated with any particular flow (Figure 5). Potential effects on striped bass of this increase in diversion were taken into account by developing new multiple regression equations which included outflow and diversion terms and considered the Delta and Suisun Bay separately (Chadwick et al. 1977). These equations yielded reasonable predictions of young bass abundance from 1959 to 1976 and provided additional evidence that losses of young fish to diversions were an important factor regulating striped bass abundance.

However, since 1977, except for 1986, the abundance of young striped bass has consistently been considerably lower than predicted by the 1959-1976 regressions (Figure 6). Both young bass abundance and our ability to predict it has been greatly reduced. The concensus among ourselves, various consultants, and other interagency staff members has been that this major reduction is most likely due to one or more of four factors (Stevens et al. 1985; CFG 1987):

1. The adult bass population, reduced by a combination of lower recruitment and higher mortality rates, produces fewer eggs. (Figure 7)
2. Production of food for young striped bass has been reduced.
3. Large numbers of striped bass eggs and young are removed from the estuary with water diverted for agriculture, power plant cooling, and other uses. Diversions do not provide a simple explanation for the reduction in young bass abundance as diversion rates were higher in the

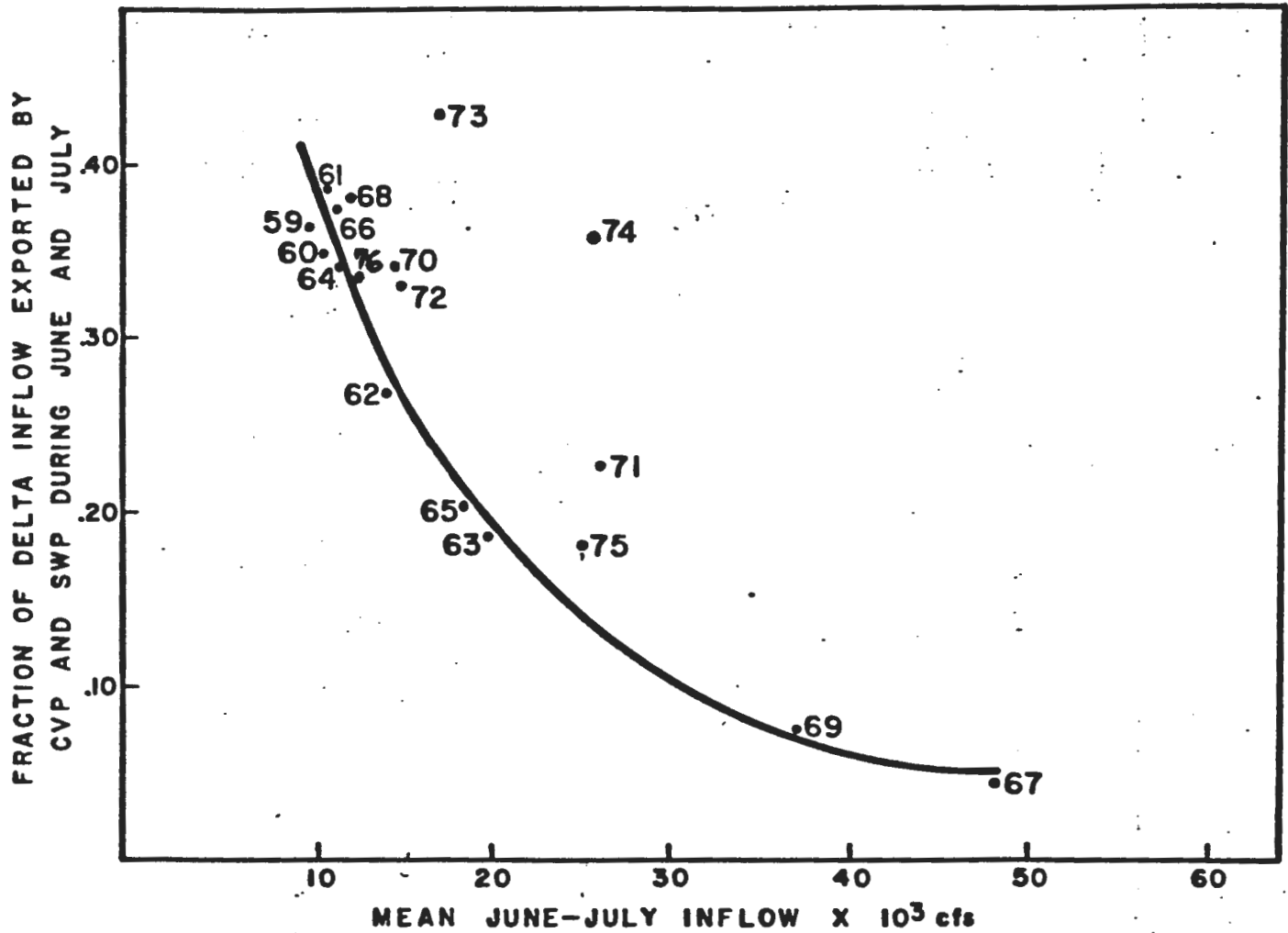


FIGURE 5.

Relationship between the fraction of June-July Inflow exported by the CVP and SWP and mean June-July inflow. Line fit to years 1959-70. Numbers adjacent to points indicate years.

38MM STRIPED BASS PREDICTED VS OBSERVED 1959-1989

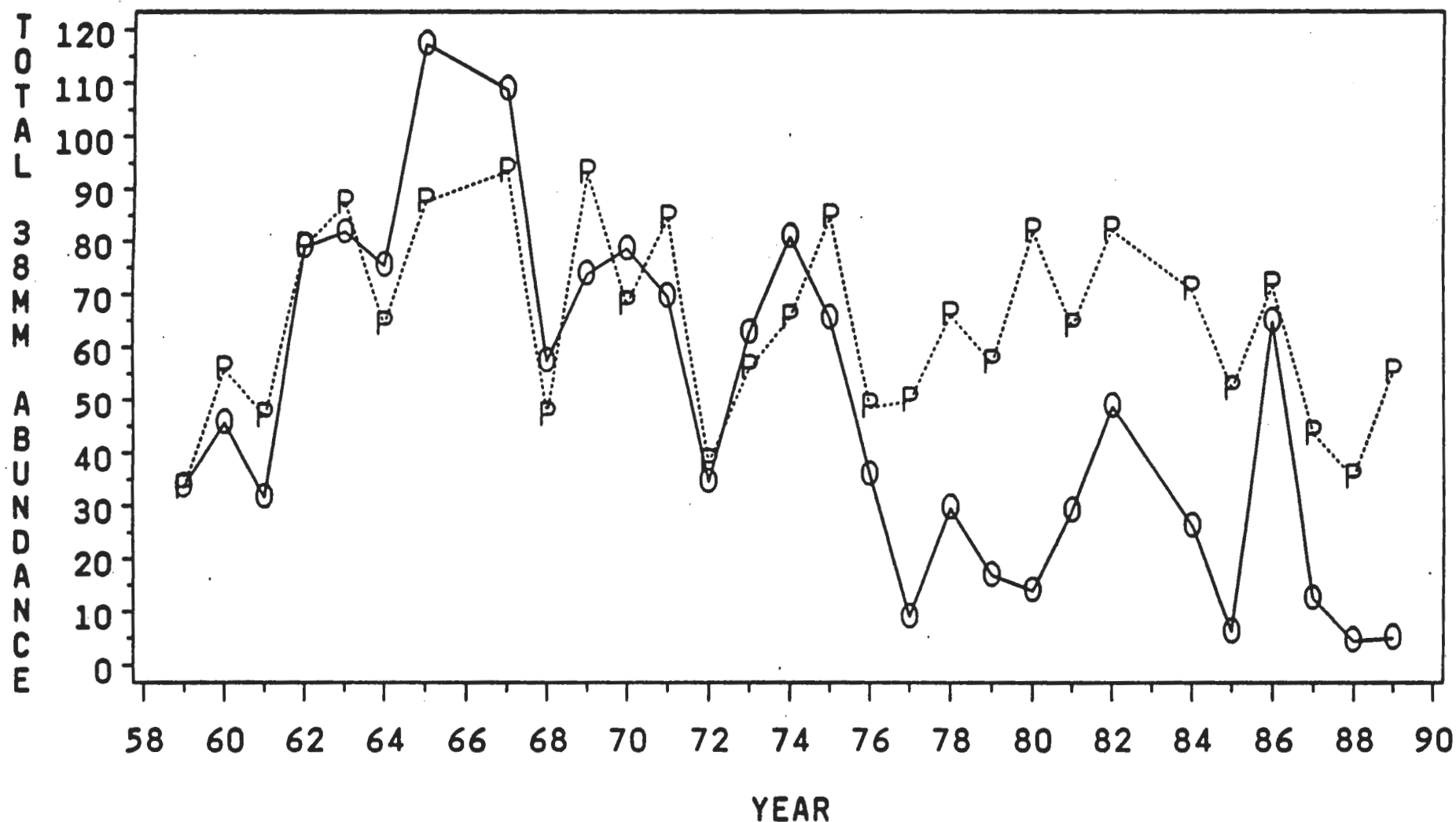


FIGURE 6. THE OBSERVED AND PREDICTED ABUNDANCE OF YOUNG OF THE YEAR STRIPED BASS WHEN THE MEAN LENGTH OF THE CATCH IS 38MM. THE PREDICTED ABUNDANCE IS BASED ON THE FOLLOWING REGRESSIONS FOR YEARS 1959-1976

$$\text{predicted delta} = -152.3 - 0.19567 * (\text{mjdiv}) + 177.7 * (\text{lmjout}) - 34.22 * ((\text{lmjout}) * (\text{lmjout}))$$

$$\text{predicted suisun} = -262.7 + 208.33 * (\text{ljout}) - 33.68 * ((\text{ljout}) * (\text{ljout}))$$

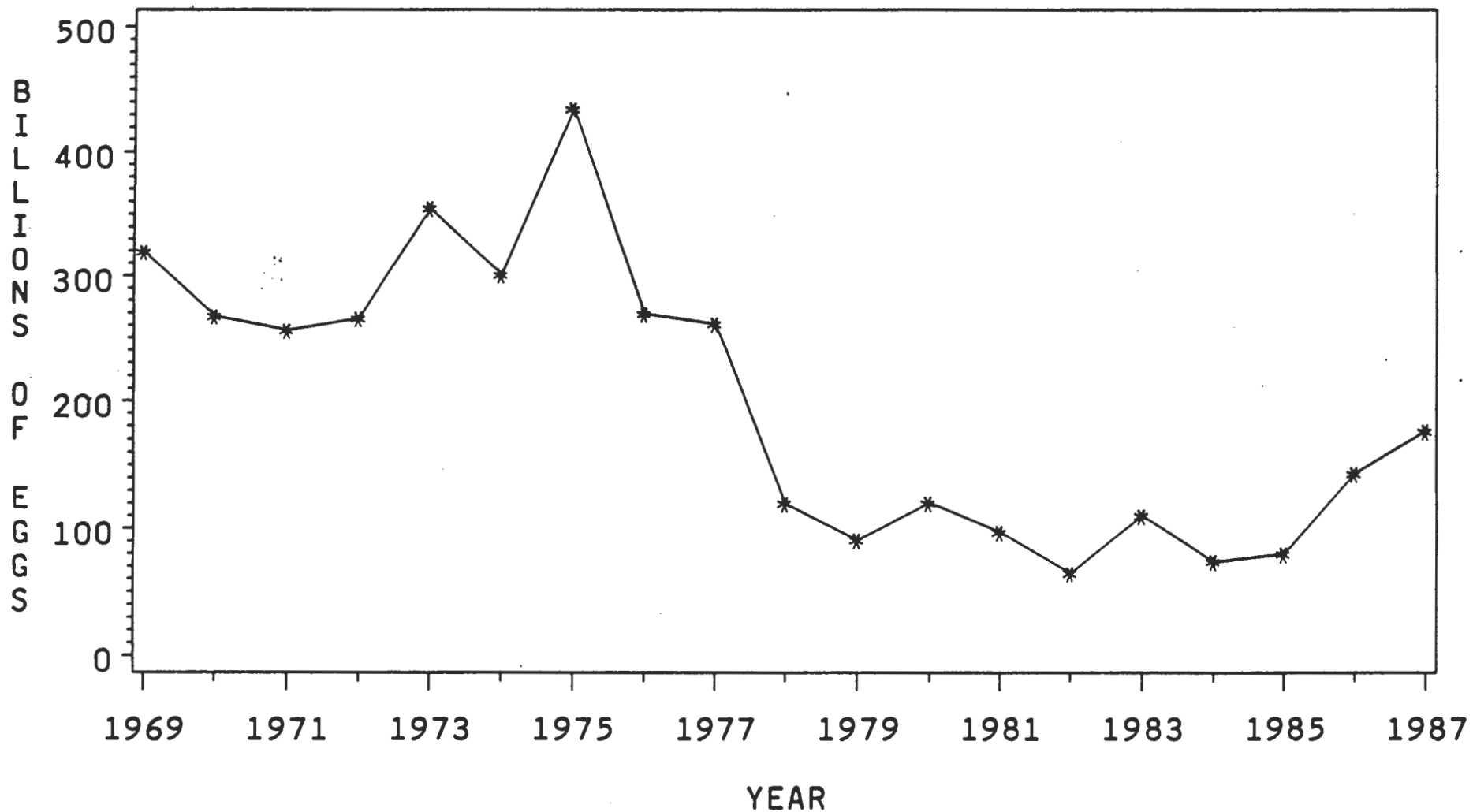


FIGURE 7. Trend in striped bass egg production estimates based on age-specific Petersen population estimates and age-specific fecundity estimates for the California striped bass population.

early and mid-1970s than they have been in the 1980s since State Water Resources Control Board Decision 1485 has been in effect. Justification for diversions as the cause of the young bass decline has to consider that the entrainment of young fish over the past 30 years probably has lowered recruitment to the adult stock and then funnel the effect of the lower stock back through the egg production hypothesis ([1] above).

4. Point and nonpoint discharges of toxicants may cause mortality of adults, reduce their ability to reproduce, or reduce the survival of their eggs and young.

WHICH HYPOTHESIS IS MOST REASONABLE?

In examining the various hypotheses that might account for the decline of young striped bass, we recently compared annual abundance indices (Table 1) for successive stages from egg to 9mm larvae (Figure 8) to evaluate if mortality might have increased at any or all stages. These comparisons yield four major points:

1. The plots comparing abundance at successive stages have strong positive correlations (with the exception of the point for 1975 in the 7-8 mm plot) revealing that abundance at each stage largely depends on abundance at the previous stage -- all the way from the egg through the 9 mm stage.

Table 1. Abundance measures for striped bass eggs, larvae, and juveniles in the Sacramento-San Joaquin Estuary.

<u>Year</u>	Petersen Egg Produc- tion Estimate (billions)	Stage				
		<u>6 mm</u>	<u>7 mm</u>	<u>8 mm</u>	<u>9 mm</u>	<u>38 mm</u>
1968	.	662245	123989	86594	74528	57.3
1970	267.2	1728147	352024	212712	102590	78.5
1971	255.6	4408569	428530	171835	75109	69.6
1972	265.4	1766699	385019	230004	116295	34.5
1973	354.3	.	.	.	70756	62.7
1975	434.2	4772381	892673	150940	51952	65.5
1977	231.5	209893	88739	22026	8913	9.0
1984	77.3	453715	91640	43061	25951	26.3
1985	92.0	1254491	128009	36790	14872	6.3
1986	142.7	1330763	328386	119563	57268	64.9
1988	.	396903	113309	35777	13624	4.6

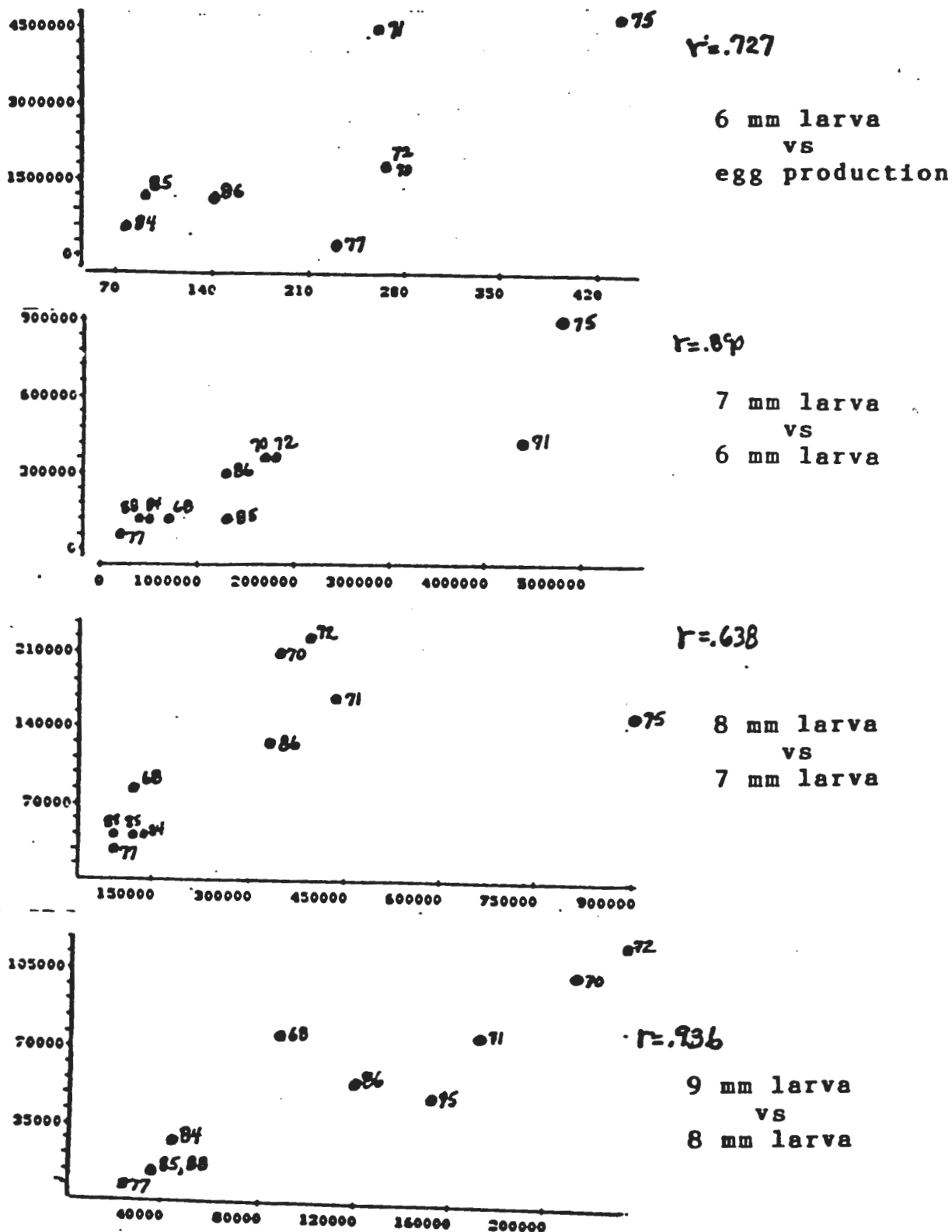
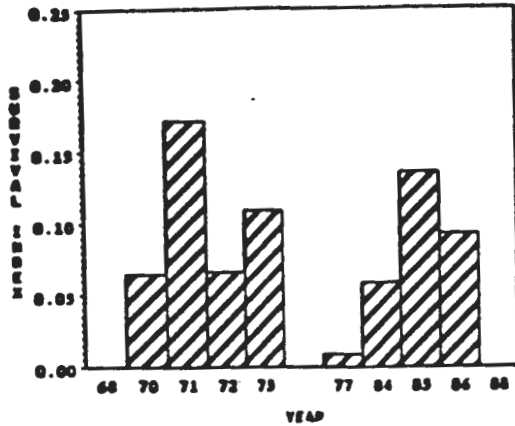


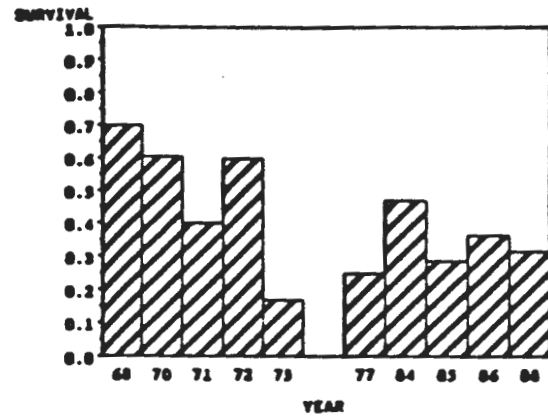
Figure 8. Correlations between measures of striped bass abundance at successive egg and larva stages. The larva abundance measures are affected by gear efficiency differences on the various stages; therefore, should be regarded as indices which are consistent only within each stage. Egg production estimates are in thousands. Egg production estimates are not available for 1968 and 1988.

2. There is no evidence of a "critical stage" at which extreme annual variations in survival determine year class strength. If there was such a stage, the correlation between it and at least one adjacent stage would be weak. The correlation coefficient between the 7 and 8 mm stages is less than the coefficients for the other stages; however, this is due to the outlier for 1975. The correlation between 7 and 8 mm bass abundance is very strong for the remaining years ($r=0.917$).
3. Data points for the various years change position somewhat between plots, possibly reflecting annual variations in survival at the various stages. Survival indices (Figure 9) demonstrate that these annual variations occurred both within the "pre-decline" period (1968-1975) and the "decline" period (1977-1988), and that survival from one stage to the next has not been consistently or significantly (Table 2) lower since 1977.
4. Points 1-3 are strong support for the hypothesis that the decline in egg production associated with the reduced spawning stock is responsible for the decline in young striped bass production since 1977. The results are contrary to the hypotheses that changes in food supply or toxicity have reduced larval bass survival in recent years. However, the results do not preclude food or toxicity as factors affecting

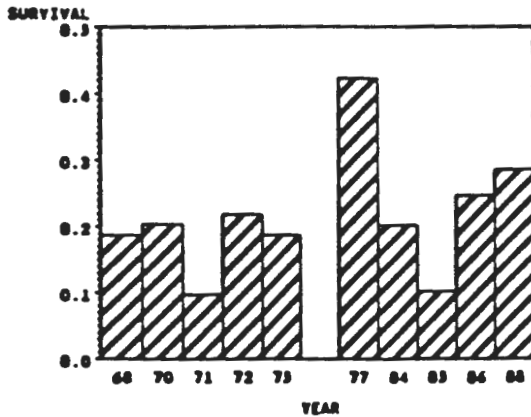
SURVIVAL FROM EGG STAGE(PETERSEN FECUNDITY) TO 6MM BASS



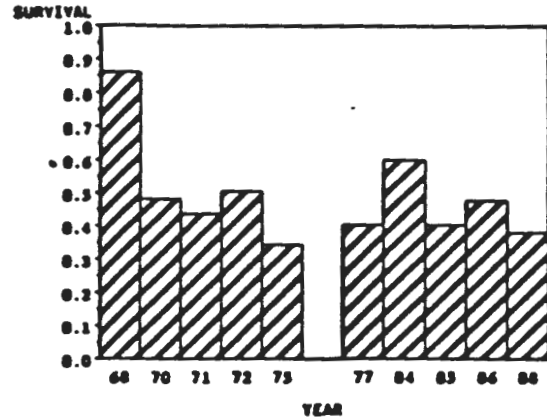
SURVIVAL FROM 7 MM STAGE TO 8 MM STAGE



SURVIVAL FROM 6 MM STAGE TO 7 MM STAGE



SURVIVAL FROM 8 MM STAGE TO 9 MM STAGE



SURVIVAL FROM EGG STAGE(PETERSEN FECUNDITY) TO 9MM BASS

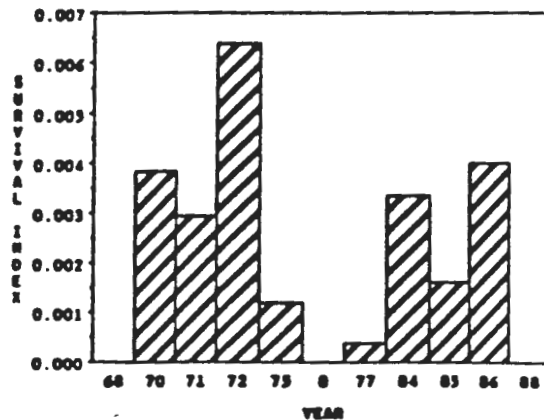


Figure 9. Survival indices for several striped bass egg and larva stages. These survival indices are affected by gear efficiency differences on the various bass stages; therefore, actual survival rates are not known and survival comparisons are valid only within, and not between, plots. Egg production estimates are not available for 1968 and 1988.

Table 2. Probabilities from Mann-Whitney tests for differences between pre-and post-1976 larval striped bass survival indices. None of the differences were statistically significant.

<u>Stage</u>	<u>Probability of Observed Difference Occurring by Chance</u>
egg - 6 mm	0.665
6 mm - 7 mm	0.210
7 mm - 8 mm	0.210
8 mm - 9 mm	0.531
egg - 9 mm	0.713

striped bass abundance. Food or toxicity may contribute to the variations in larval bass survival that apparently occurred during both the "decline" and "pre-decline" periods.

LARVAL STRIPED BASS ABUNDANCE AND POST-LARVA SURVIVAL DETERMINE THE YOUNG BASS INDEX

To explore the importance of larva abundance to ultimate year class strength as measured by the young striped bass (38 mm) index, we plotted the 38 mm indices against the 9 mm indices (Figure 10, updated from CFG 1987). This plot shows a good statistical correlation between the two measures of bass abundance, indicating that the abundance of larvae is important to year class success--if there aren't many larvae, abundance will be low at the 38 mm stage. Nevertheless, much variability in 38 mm bass abundance, particularly in the upper right portion of figure 10, remains unexplained by this relationship. Hence, there may be substantial annual fluctuations in survival between the 9 mm and 38 mm stages.

Two questions immediately arise: 1) Is "fluctuating survival" a proper interpretation of the unexplained variability in 38 mm bass abundance? 2) Could this "fluctuating survival" reflect the same influence of outflow and diversions that was so apparent in the 38 mm abundance index before 1976?

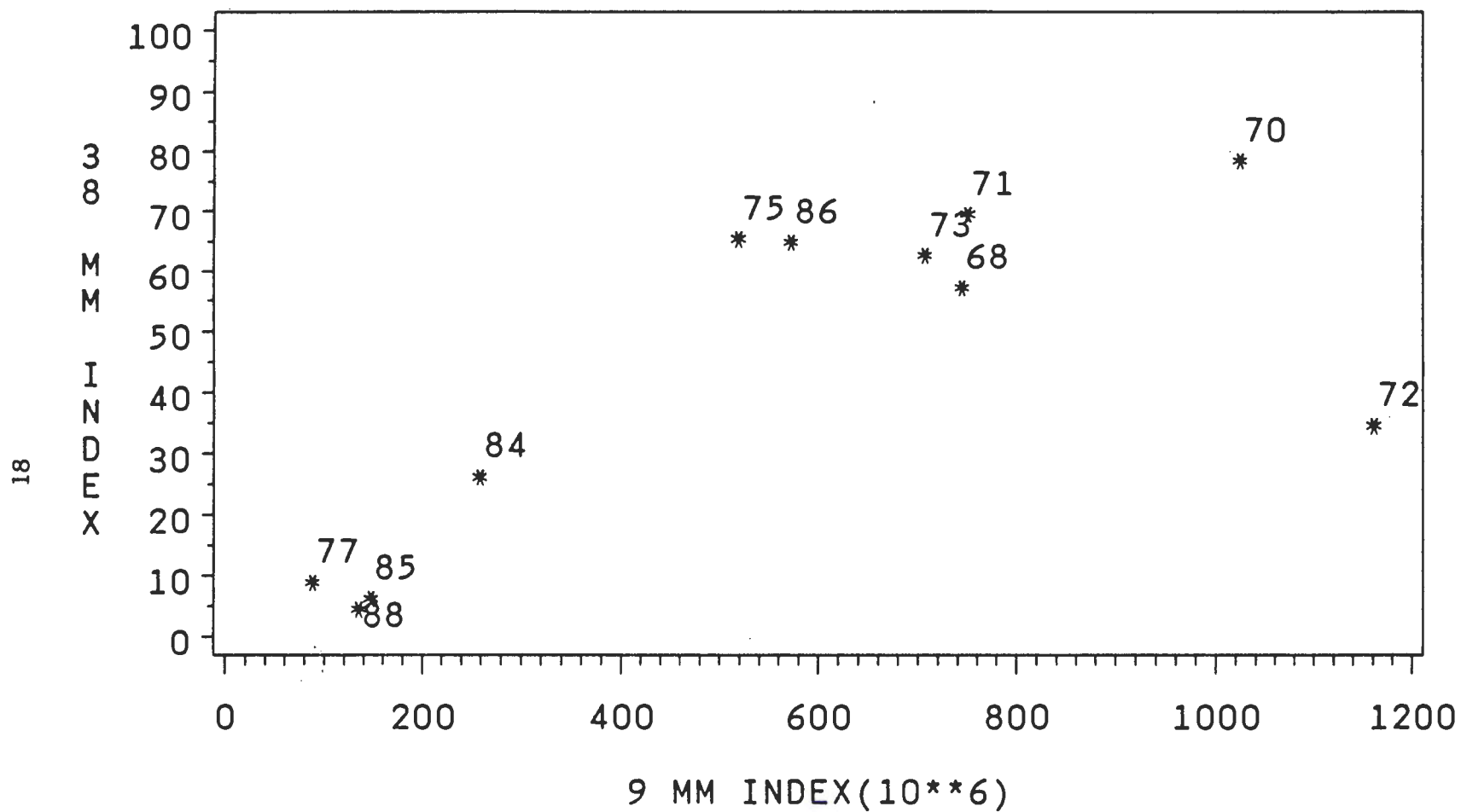


FIGURE 10. Correlation between striped bass 38 mm juvenile index and 9 mm larva abundance in the Sacramento-San Joaquin Estuary. The correlation coefficient = 0.720.

The logical approach to answering these questions is to examine, for the entire period of record, the potential influence of outflow and diversions on survival between the 9 mm and 38 mm stages instead of simply looking at the relationship of outflow and diversions to 38 mm abundance. Thus, we indexed young striped bass survival (S) as:

$$S = \frac{\text{young bass (38 mm) index}}{\text{9 mm abundance index}} .$$

Survival was then plotted against outflow (Figure 11). This plot provided two important revelations: 1) Except for 1977, there is a very good correlation between post-9 mm survival and outflow, 2) the relationship between survival and outflow is consistent over the entire period of record -- there is no difference between pre-decline and decline years.

Now, can we account for the high survival in 1977 and "tighten up" the relationship in figure 11? The answer is "yes"! Water exports were very low in 1977, and when diversion rates and outflows are used in a multiple regression equation to predict 9-38 mm survival, there is excellent agreement between "observed" and "predicted" survival over the entire period of record (Figure 12). Outflow and diversion rates were both statistically significant ($p < 0.05$) in this regression. Simply put, the agreement between "observed" and "predicted" survival is evidence that: 1) "Variable survival" is a proper interpretation of Figure 10. 2) Outflow and water diversions continue to be

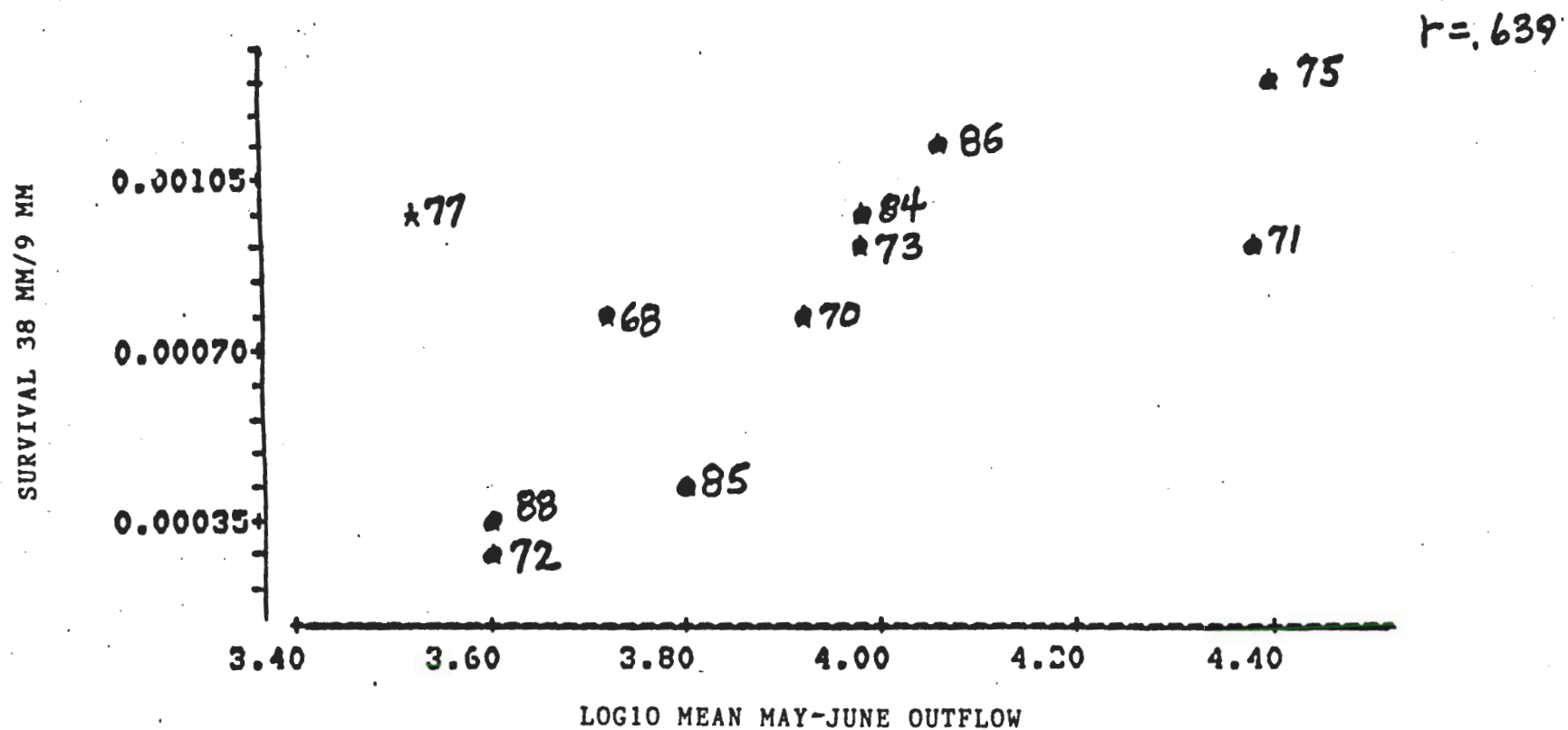


Figure 11. Correlation between survival from 9 mm to 38 mm stage and \log_{10} mean May-June outflow.

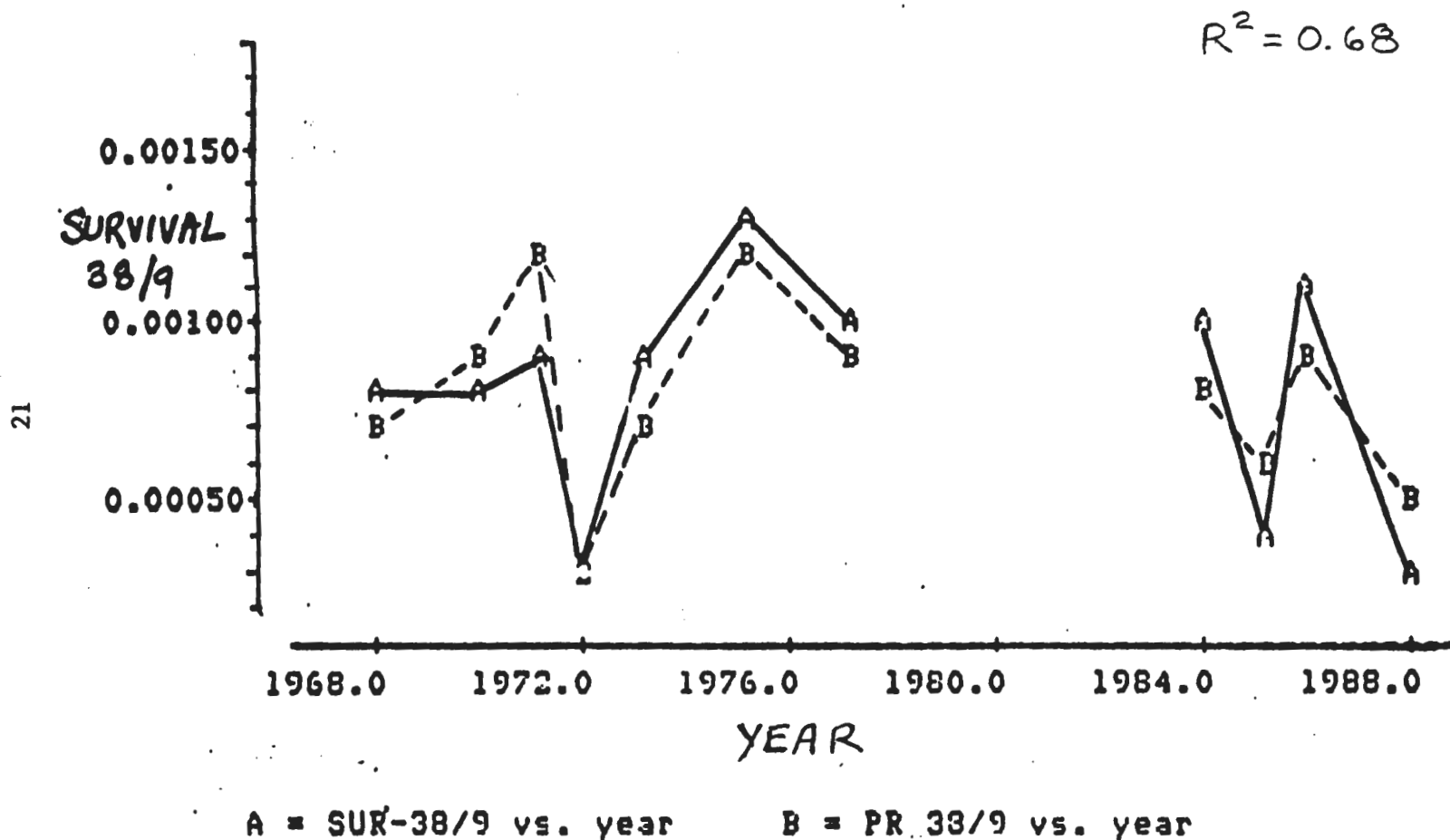


Figure 12. Comparison between observed survival from 9 mm to 38 mm striped bass stages and survival predicted from May-June outflow and water exports. Predicted survival = $0.00148 - 0.00000012$ (mean May-June exports) + $.000749 (\log_{10} \text{ mean May-June outflow})$.

major determinants of striped bass year class strength, just as they always have.

Further, these results, in conjunction with figures 8 and 9, support the contention that the major reductions in eggs and larvae have caused the decline in production of 38 mm bass.

WHY HAVE THE ADULT STOCK AND ITS EGG PRODUCTION DECLINED?

Why have the adult stock and its egg production declined? The following facts strongly implicate water project operations.

1. Recruitment of a year class to the adult stock depends on its abundance when young (Stevens et al. 1985; CFG 1987).
2. Water diversions and outflow have major effects on young striped bass survival, as described in this paper.
3. The adult striped bass population began declining after peak levels of the early 1960s. Recruitment at this time consisted of the first year classes to be affected by major water exports during a relatively dry period (1959-1961).
4. During the initial years of the post-1976 decline in young bass production, the spawning stock depended on year classes affected by the increased water exports of

the early 1970s when the SWP initiated major exports and the CVP increased exports. Young striped bass losses at the SWP and CVP diversion points were substantial from 1970 to 1975 (Tables 19 and 20 in CFG 1987).

The importance of past production of young bass (38 mm index) and subsequent losses of these fish to water exports can be demonstrated quantitatively through a multiple regression analysis. The combination of young bass abundance as measured by the sum of the 38 mm indices 5 to 8 years earlier and the sum of losses of 21-150 mm bass at the SWP and CVP diversions 5 to 8 years earlier (Table 20 in CFG 1987) explain 63% of the variability in striped bass egg production and provide a good simulation of the overall trend in egg production from 1969 to 1987 (Figure 13). Five to 8 years was selected as the appropriate time lag for this analysis because 5-8 year old fish produce the bulk of the eggs (50-80%). While the size range of fish estimated lost to SWP-CVP operations includes bass smaller than 38 mm, loss estimates solely for fish larger than 38 mm are not presently available. This analysis will be refined as soon as estimates of larger fish only are calculated.

Assuming that the loss estimates for 21-150 mm bass provide a good representation of losses after the 38 mm stage, the overall conclusion is that the abundance of spawners and their egg production are determined largely by the production of 38 mm bass 5-8 years earlier and subsequent losses of those fish to SWP-CVP export operations. The heavy losses of young fish to the SWP and

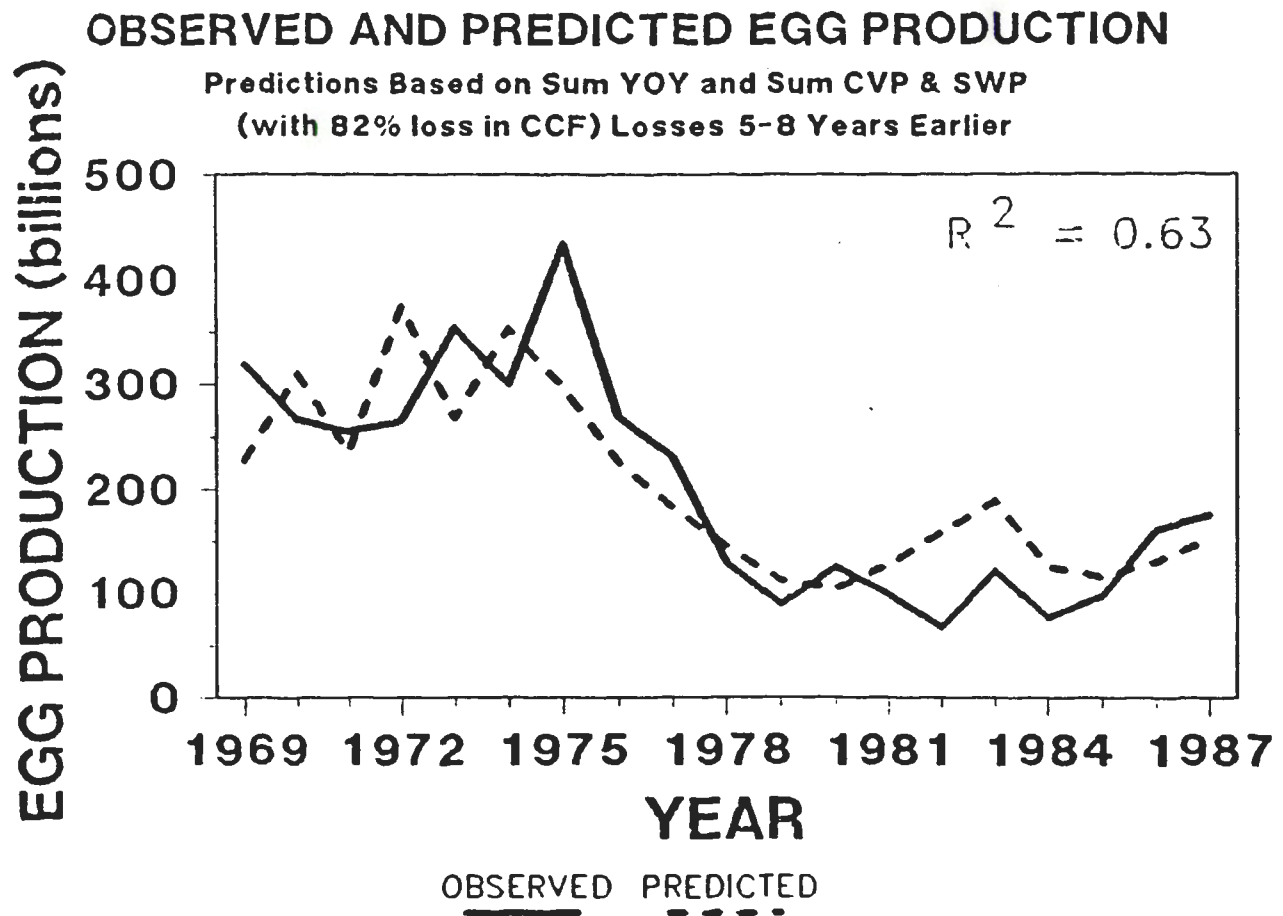


Figure 13. Comparison between observed striped bass egg production (Petersen fecundity estimates) and egg production predicted from a multiple regression of egg production on the sum of 38 mm abundance indices 5-8 years earlier and the sum of young striped bass loss estimates at the SWP/CVP export facilities 5-8 years earlier. Egg production = $-1174 + 0.876 (\text{sum } 38 \text{ mm index}) - .00000059 (\text{sum young bass losses})$.

CVP during the early 1970s appear responsible for the sharp decline in the striped bass spawning stock and its egg production during the mid- to late 1970s.

SUMMARY AND CONCLUSIONS

- 1) The evidence is strong that outflow and water diversions continue to have major effects on striped bass year class strength. Several facts indicate that the diversion component is an important part of these effects:
 - a) the initial (1971-1976) stages of the decline in young bass abundance apparently occurred in response to increased SWP/CVP water exports,
 - b) this initial (and most striking) decline occurred primarily in the Delta portion of the nursery where the major diversions are located, and
 - c) estimated impacts (CFG 1987) of losses of young fish in SWP/CVP water exports are substantial (Combined SWP and CVP losses were estimated to cause a 73% reduction in bass abundance by the 20 mm stage in 1985, a dry year; a 31% reduction by the 20 mm stage in 1986, a wet year; and an 84% reduction by the 20 mm stage in 1988, another dry year.).

It is also clear that outflow impacts are closely intertwined with those of diversions because outflow affects the geographical distribution of young bass, and thus their

susceptibility to being diverted. Additionally, high outflow may have other positive benefits as stated earlier in this paper, but their relative importance cannot be distinguished at present.

- 2) In regard to the post-1976 decline in young striped bass production, the evidence is contrary to the hypotheses that changes in food supply and/or toxicity have reduced larval bass survival, but consistent with the hypothesis that the decline in young bass has been caused by the reduced adult stock and its egg production. Abundance of each larval stage is closely correlated with abundance at the previous stage, and there is no indication of consistent lower post-1976 survival. There also is no evidence of a critical larva stage at which extreme annual variations in survival determine year class strength.
- 3) Several facts strongly implicate heavy water exports in the early 1970s as the cause of the sharp decline in the striped bass spawning stock and its egg production during the mid- to late 1970s. We have demonstrated these impacts quantitatively through a multiple regression analysis indicating that the abundance of spawners and their egg production are determined largely by the production of 38 mm bass 5-8 years earlier and subsequent losses of those fish to SWP-CVP export operations.

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